

TFAWS Panel Discussion



Thermal Testing Facilities & Efforts at Dryden Flight Research Center

Presented By
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Thermal & Fluids Analysis Workshop
TFAWS 2010
August 16-20, 2010
Houston, TX





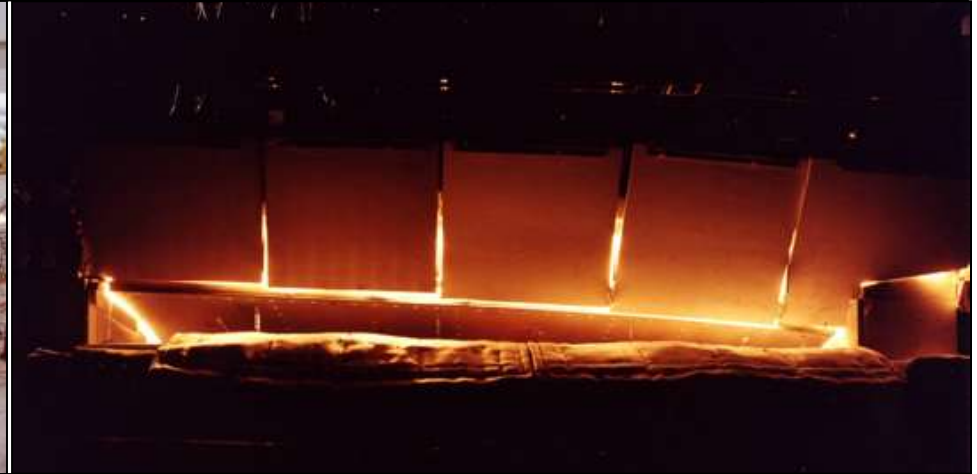
DFRC Thermal Test Facilities



Flight or Full Vehicle Ground Test



Subcomponent Thermal-Structural (Air/Inert)



Test Article Thermal (Air/Inert)



High-Temperature Instrumentation (Air/Inert)





DFRC Thermal Test Facilities



- **Flight Test**
 - Testbed aircraft (F-15D, F-15B, F-18s, GIII, Ikhana) with flight qualified IR, thermal instrumentation
- **Ground Test**
 - **Flight Loads Laboratory**
 - 164' x 120' High Bay, 20' x 23' x 10' Nitrogen Chamber
 - Large-scale thermal (subcomponents to full aircraft)
 - Custom contoured banks of quartz lamps (2500°F) or graphite heaters (>3000°F)
 - Simulate supplied trajectory → Temperature, strain, thermal stress distributions, & deflection
 - Large-scale thermal-structural (subcomponents to full aircraft)
 - Simulate supplied trajectory & loads → Temperature, strain, stress, thermal stress distributions, & deflection
 - Hot modal survey → study effect of heating on mode shapes, natural frequencies, and damping
 - High-Temperature Instrumentation
 - Sensor characterization & validation under hypersonic environmental conditions
 - Develop instrumentation (strain, temperature, accelerometers, heat flux) attachment techniques for hypersonic materials exposed to extreme environments
 - NDE (Non-Destructive Evaluation)
 - Develop techniques to inspect hypersonic structures
 - **Environmental Laboratory**
 - Test Chambers
 - Test aircraft components for proper functioning at altitude pressure & temperature



DFRC Thermal Test Facilities



F-15B



F-18



G-III/C-20A



Ikhana



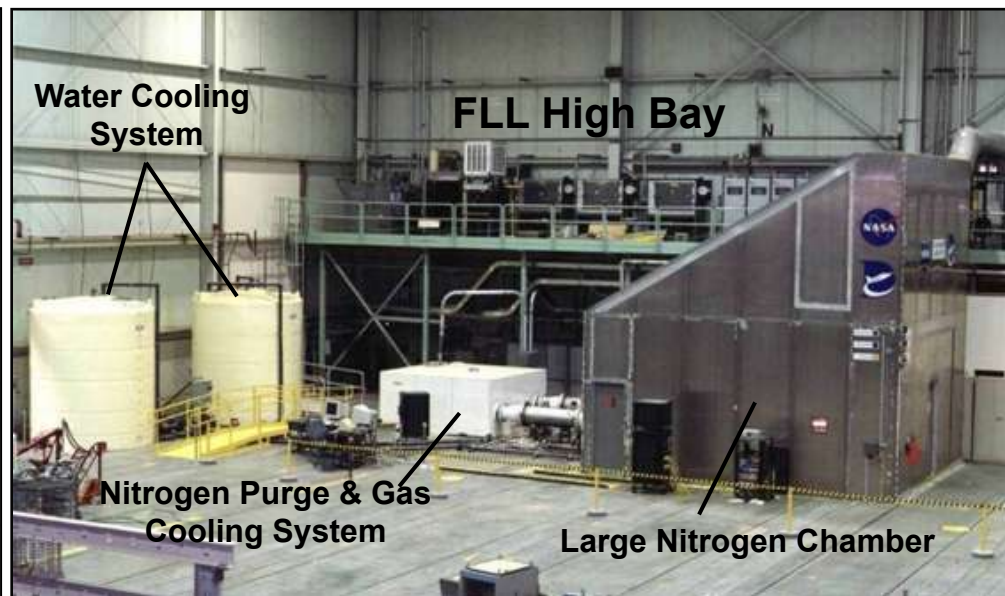
COMING SOON: F-15D



Large Nitrogen Chamber



**Flight Loads Laboratory
(FLL)**



**Water Cooling
System**

FLL High Bay

**Nitrogen Purge & Gas
Cooling System**

Large Nitrogen Chamber



DFRC Thermal Testing Facilities

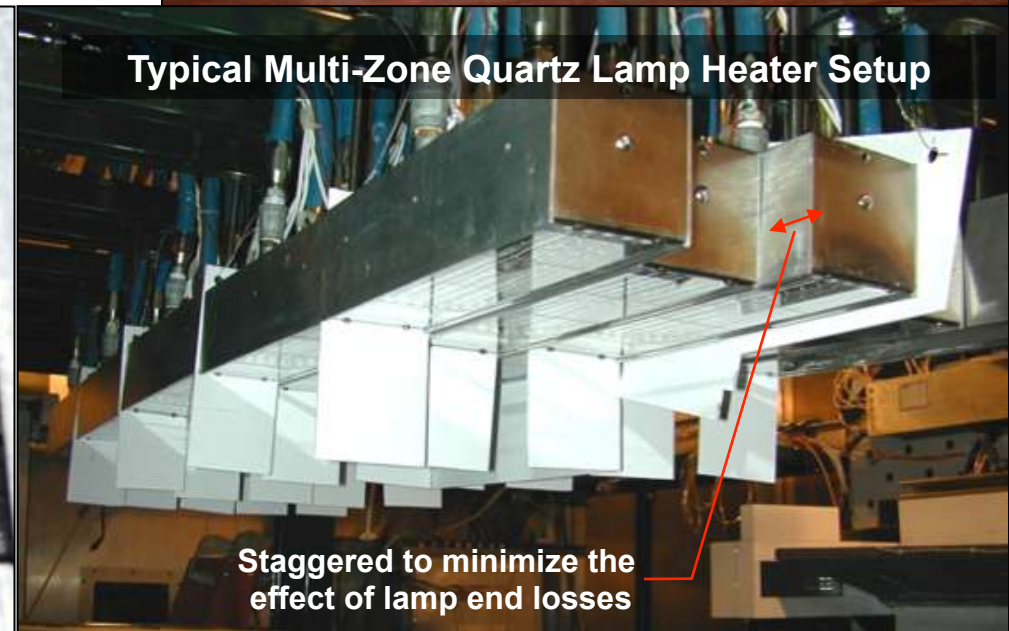
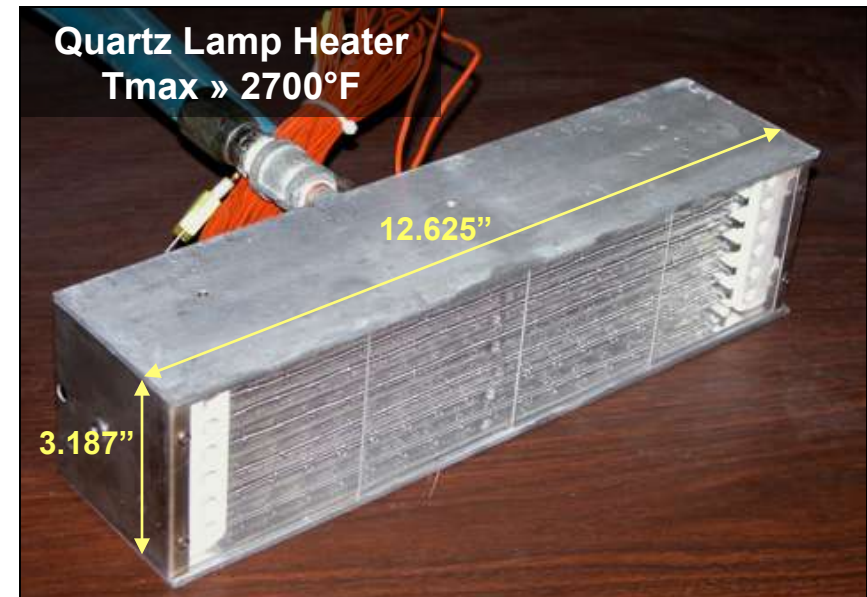


- **Quartz Lamps**

- For application $< 2700^{\circ}\text{F}$
- Polished aluminum reflector
- Water & gas cooled
- Quartz window
- Six 2000W quartz lamps
- 36KW @ 480V (double rated)

- **Graphite Heaters**

- For applications $> 2700^{\circ}\text{F}$
- Test article temperatures beyond 3000°F
- Requires purged environment





DFRC Thermal Testing

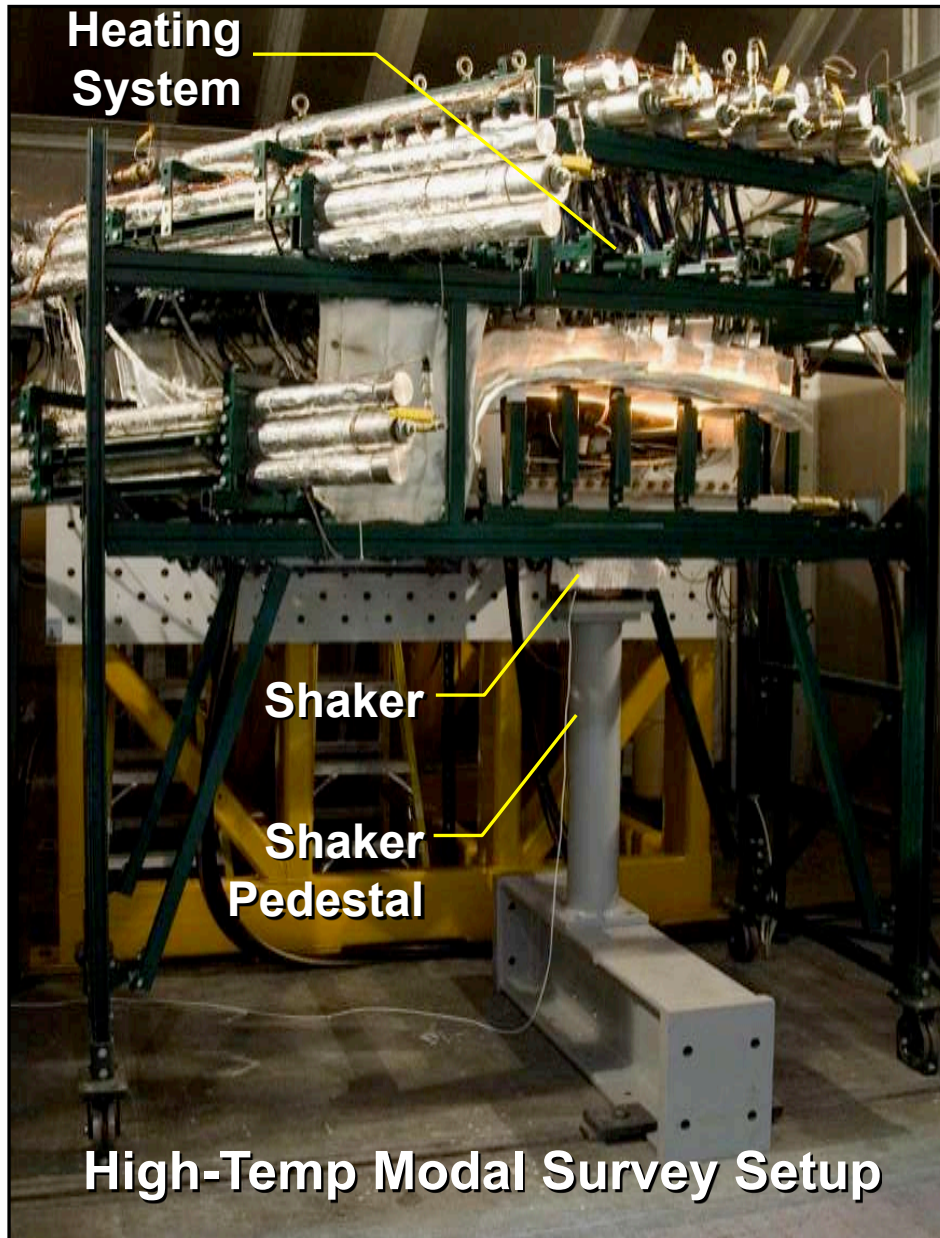


- Flight Test
 - SBLT (Supersonic Boundary Layer Transition)
 - IR investigation of BLT
- Flight & Ground Test
 - SOFIA
 - Thermal stress in imager components, no longer a concern due to analysis & flight test
 - Cavity vent door operation at altitude/temperature, ground testing performed, doors modified
 - Thermal stress in aircraft members due to telescope cavity pre-cool, analyses in-work, ground & flight tests providing data



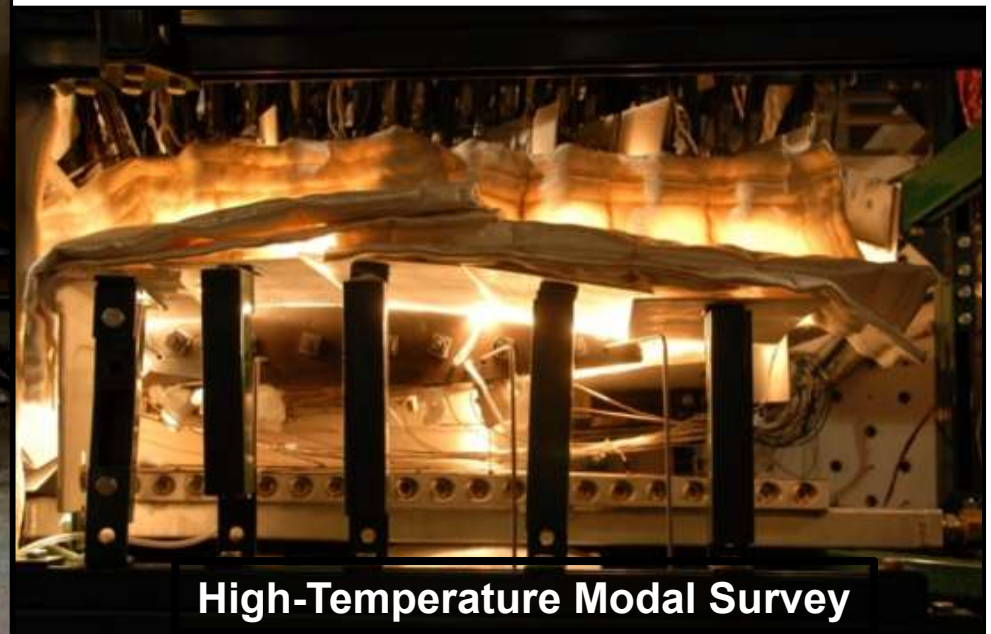


DFRC Thermal Testing



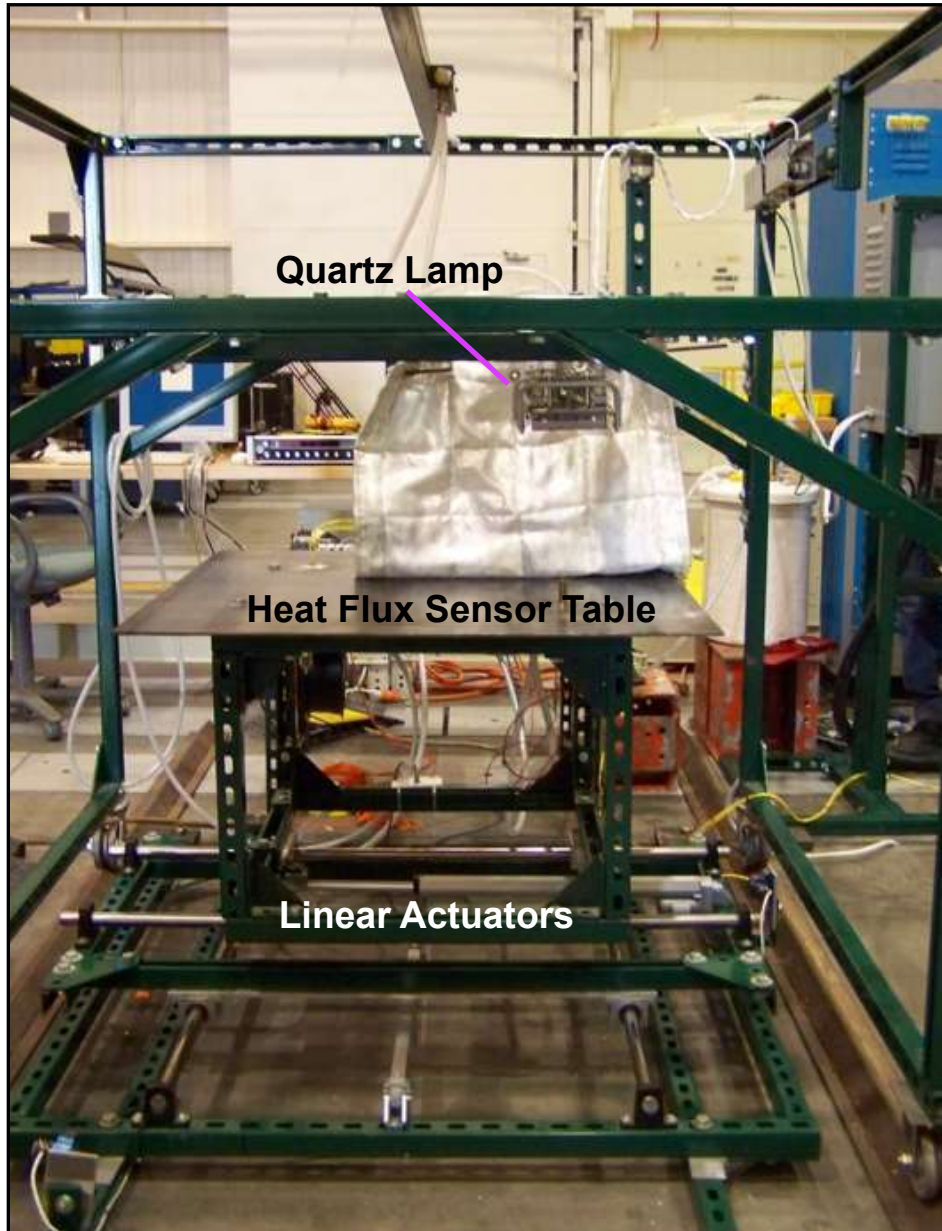
- **Ground Test**

- X-37 Ruddervator Thermal-Structural Testing & High-Temperature Modal Survey
 - NASA DFRC / LaRC, Lockheed-Martin, Materials Research & Design, GE CCP
 - Extensive test series investigating structural response of control surface under uncoupled & coupled thermal & structural loading given various profiles
 - High-temperature testing to examine dynamic response temperature variation

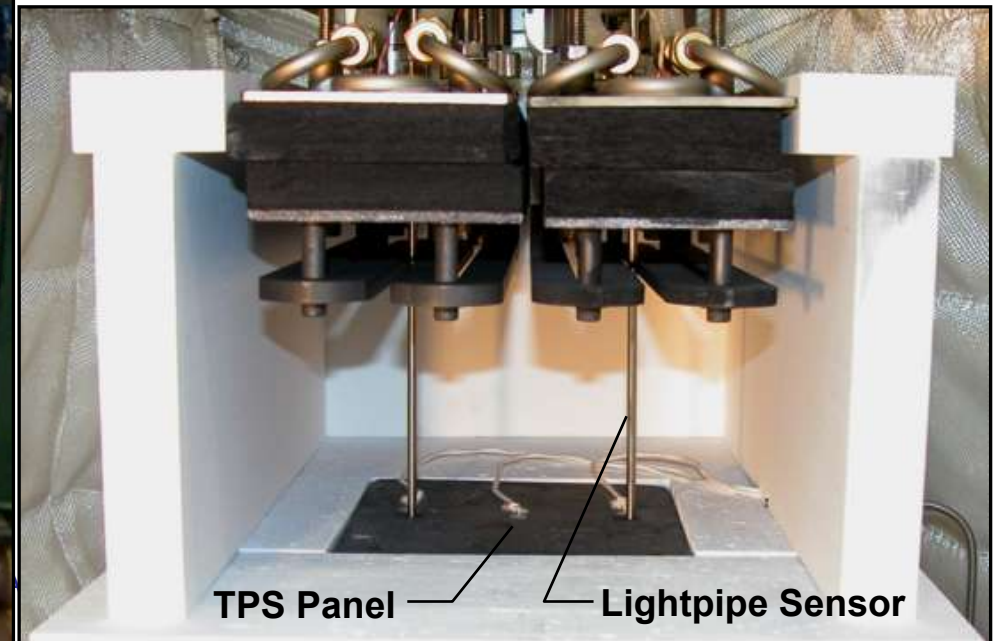




DFRC Thermal Testing



- Ground Test (cont'd)
 - SITPS
 - Test effectiveness of integrated structural and thermal load bearing structures
 - Advanced TPS Concepts
 - Test effectiveness of novel TPS concepts
 - Heat Flux Mapping
 - Characterize spatial distribution of lamp & reflector combinations for test/analysis correlation and to improve understanding & configuration of future heater designs

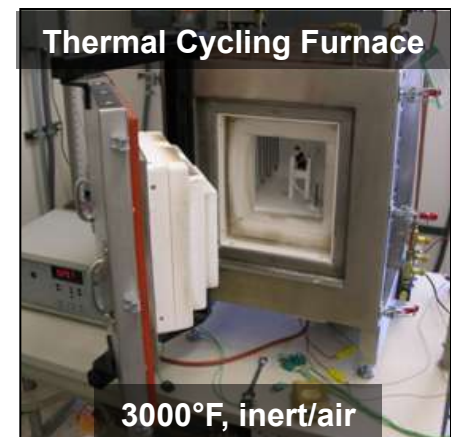
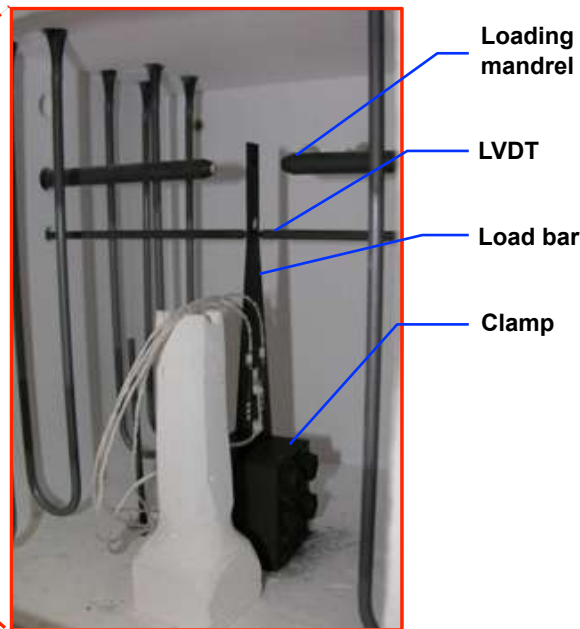
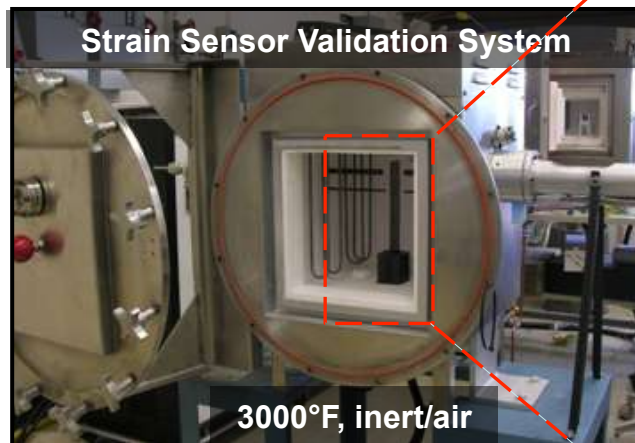




DFRC Thermal Testing



- Ground Test (cont'd)
 - High Temperature Sensor Testing
 - Develop attachment techniques for hot structure materials (C-C, C/SiC)
 - Validate attachment through characterization testing
 - Investigate sensor performance across temperature range for temperature, flux, strain sensors



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